
WINTER – 15 EXAMINATION Subject Code: **17529** **Model Answer**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q1 A a)

$$V_s = \frac{\pi}{4} d^2 l = \frac{\pi}{4}(0.25)^2 \times 0.375$$

$$= 0.01841 m^3 \quad \text{— (1 mark)}$$

$$\text{Compression Ratio } (r_c) = 1 + \frac{V_s}{V_c}$$

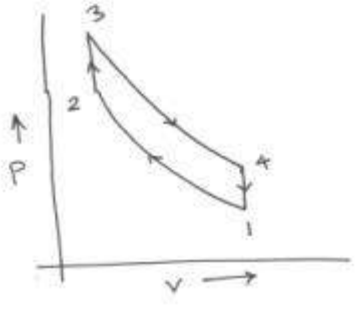
$$= 1 + \frac{0.01841}{0.00263}$$

$$= 8 \quad \text{- (1 mark)}$$

$$\eta_{air\ std.} = 1 - \frac{1}{r_c^{\gamma - 1}}$$

$$= 1 - \frac{1}{(8)^{1.4-1}}$$

$$= 56.47\% \quad \text{— (1 mark)}$$



OTTO CYCLE

(1 mark)

Q.1 (A) (b) Following are the Industrial uses of compressed air - *(Any Eight)* 1/2 mark each

1) To drive air motors in coal mines.
2) To inject fuel in air injection diesel engines.
3) To operate pneumatic drills, hammers, hoists, sand blasters.

4) For cleaning purposes.
5) To cool large buildings.
6) In the processing of food and farm maintenance.
7) For spray painting in paint industry.
8) In automobile & railway braking systems.
9) To operate air tools like air guns.
10) To hold & index cutting tools on machines like milling / cnc machines.

Q.1 (A) (c) (1 mark each)

i] Compressor capacity:-

- It is the volume of air delivered by the compressor in m^3 per minute
- It is express in m^3/min

ii) FAD:-

- It is the volume of air delivered by compressor under the intake conditions of temperature and pressure.
- Capacity of compressor is generally given in terms of free air delivery.
- Unit = m^3/cycle

iii) Volumetric Efficiency:

It is the ratio of actual volume of air delivered at standard atmospheric condition discharge in one delivery stroke to the swept volume by the piston during the stroke.

iv) Mechanical Efficiency: It is the ratio of Indicated power to shaft (brake) power.

Q.1 (A) (d)

In S.I. engine, the spark is timed to occur at a definite point just before the end of the compression stroke. If the ignition starts, due to any other reason, when the piston is still doing its compression stroke, it is known as pre – ignition. **(2 marks)**

Following factors are responsible for Pre – ignition

1) High compression ratio
2) Overheated spark plug
3) Incandescent carbon deposit in cylinder wall
4) Overheated exhaust valve
5) It may occur due to faulty timing of spark production **(Any two – 2 marks)**

Q.1 (B) (a)

Q1. (B) (a)

Compression ratio $= r_c = \frac{V_1}{V_2} = 8$

$T_3 = 2001\,°K \quad T_1 = 299\,°K$

$\frac{T_2}{T_1} = r_c^{\gamma-1} \qquad T_2 = T_1 \cdot r_c^{\gamma-1}$

$= 299 \times (8)^{1.4-1}$

$= 686.9\,°K$ (2 marks)

$\frac{T_3}{T_4} = r_c^{\gamma-1} \qquad T_4 = T_3 / r_c^{\gamma-1}$

$= \frac{2001}{(8)^{1.4-1}} = 871\,°K$ (2 marks)

$W = Q_s - Q_R$

$= mC_v(T_3 - T_2) - mC_v(T_4 - T_1)$

$= mC_v[T_3 - T_2 - T_4 + T_1)$

$= \frac{1}{60} \times 0.718\,[2001 - 687 - 871 + 299]$

$= 8.88$ KJ/s

$= 8.88$ KW (2 marks)

Q.1 (B) (b) Effect of pollutants on environment **(any three - 6 marks.)**

The major air pollutants emitted by petrol & diesel engines are CO_2, CO, HC, NO_x, SO_2, smoke & lead vapour.

Effect of CO:

- Carbon monoxide combines with hemoglobin forming carboy hemoglobin ,which reduces oxygen carrying capacity of blood.
- This leads to laziness, exhaustion of body & headache.
- Prolong exposure can even leads to death.
- It also affects cardiovascular system, thereby causing heart problem

Effect of CO_2: Causes respiratory disorder & suffocation.

Effect of NO_x:

It causes respiration irritation, headache, bronchitis, pulmonary emphysema, impairment of lungs, and loss of appetite & corrosion of teeth to human body.

Effect of HC:

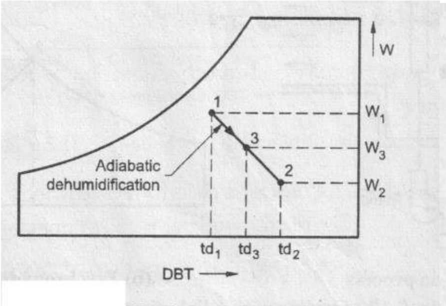
- It has effect like reduced visibility, eye irritation, peculiar odour & damage to vegetation & acceleration the cracking of rubber products.
- It induce cancer, affect DNA & cell growth are know a carcinogens.

Effect of SO_2: It is toxic & corrosive gas, human respiratory track of animals, plants & crops.

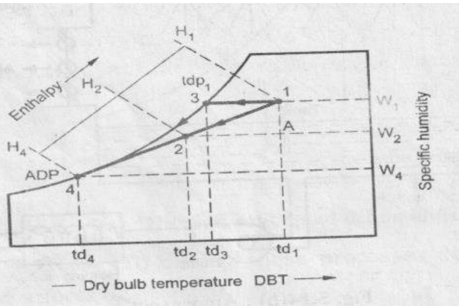
Q.2 a) Differentiate (any eight) each for 1 mark

Reciprocating compressor	Rotary compressor
1. Compression of air takes place with help of piston and cylinder arrangement with reciprocating motion of piston.	1. Compression of air takes place due to rotary motion of blades.
2. Delivery of air intermittent.	2. Delivery of air is continuous.
3. Delivery pressure is high i.e. pressure ratio is high.	3. Delivery pressure is low, i.e. pressure ratio is low.
4. Flow rate of air is low.	4. Flow rate of air is high.
5. Speed of compressor is low because of unbalanced forces.	5. Speed of compressor is high because of perfect balancing.
6. Reciprocating air compressor has more number of moving parts.	6. Rotary air compressor has less number of moving part.
7. It needs proper lubrication and more maintenance.	7. It required less lubrication and maintenance.
8. Due to low speed of ration it can't be directly coupled to prime mover but it requires reduction of speed.	8. Rotary air compressor can be directly coupled to prime mover.
9. It is used when small quantity of air at high pressure is required.	9. It is used where large quantity of air at lower pressure is required.

Q2 b) Heating with Dehumidification process : By this process, specific humidity of air decreases and its dry bulb temperature increases. This type of process is suitable for industrial air conditioning where low relative humidity is required. This process is achieved by passing a stream of air over chemicals which have an affinity for water. The process is shown in figure.



Heating and dehumidification



Cooling and dehumidification

Cooling with Dehumidification process : This process is used when atmospheric condition is hot and humid. To decrease the humidity of air it is passed over a cooling coil whose temperature is less than dew point temperature of air. As the air passes over the cooling coil, the moisture in air condenses and its temperature is also decreased

Q2. (c)

Heat supplied $= m_f \times C.V.$

$= \frac{10.5}{60} \times 43000$

$= \underline{7525 \text{ KJ/min}}$ (100%) (1 mark)

Heat equivalent to B.P. = 31.5 KW

$= 31.5 \times 60 = \underline{1890 \text{ KJ/min}}$ (25.11%) (1 mark)

Heat lost to cooling water $= m_w \cdot C_w \cdot \Delta T$

$= \frac{540}{60} \times 4.2 \times 56$

$= \underline{2116.8 \text{ KJ/min}}$ (28.13%) (1 mark)

Heat lost to exhaust gases $= m_{eg} \cdot C_{eg} \cdot \Delta T$

$= \frac{210}{60} \times 1 \times (82-17)$

$= \underline{227.5 \text{ KJ/min}}$ (3.02%) (1 mark)

$m_{eg} = m_a + m_f$

$= m_f \left[1 + \frac{m_a}{m_f}\right]$

$= 10.5 [1 + 19]$

$= \underline{210 \text{ Kg/hr}}$ (1 mark)

Heat lost by exhaust gases in calorimeter $= m_w \cdot C_w \cdot \Delta T$

$= \frac{545}{60} \times 4.2 \times 36$

$= \underline{1373.4 \text{ KJ/min}}$ (18.25%) (1 mark)

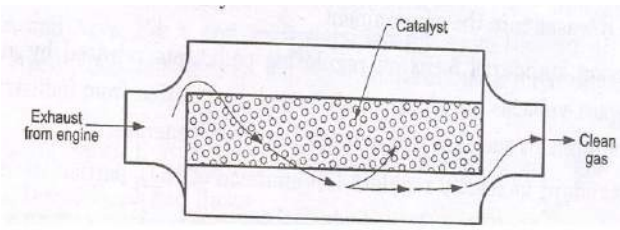
Unaccounted Heat = Heat Supplied − [B.P. + Heat lost to cooling water + Exhaust + Calorimeter]

$= 7525 - [1890 + 2116 + 227.5 + 1373.5]$

$= \underline{1917 \text{ KJ/min}}$ (25.5%) (1 mark)

Heat Balance Sheet – 1 mark

Q 3. (a) Catalytic converter: 2 Marks

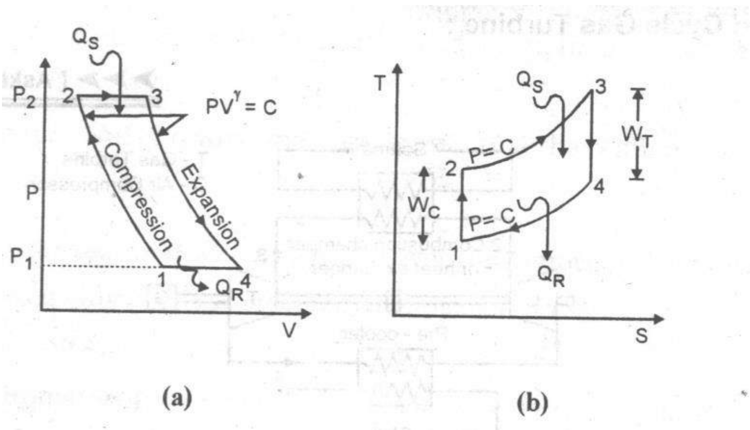


Catalytic converter is a device which converts harmful pollutants to harmless gases. Catalytic converter is used in exhaust emission in control system to convert CO, NO_x, HC and other harmful gases to harmless gases.

A Catalytic converter consists of a cylindrical unit of small size like a small silencer and is installed into the exhaust system of a vehicle. It is placed between the exhaust manifold and the silencer.

Inside the cylindrical tube i.e. converter there is a honey comb structure of a 'ceramic or metal' which is coated with 'alumina base' material and there after a second coating of precious metals 'platinum, palladium or rhodium' or combination of the same. This second coating serves as a catalyst. A catalyst is a substance which causes a chemical reaction intro the gases. When the exhaust gases pass over the converter substance, the toxic gases as CO, HC & NO_x are converted into harmless gases as CO_2, H_2 & N_2. **----- 2 Marks**

Q. 3 (b) Constant pressure closed cycle gas turbine : (sketch 02, process : 01,efficiency 01)



Process 1-2 : Isentropic compression

Process 2-3: Heat addition at constant pressure

Process 3-4 : : Isentropic expansion

Process 4-1: Heat rejection at constant pressure

$$\eta_{th} = 1 - \frac{1}{(R_p)^{\frac{\gamma-1}{\gamma}}}$$

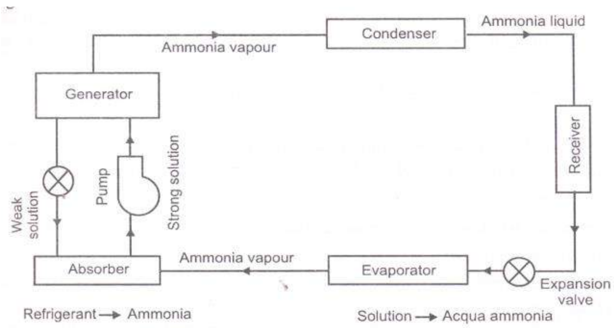
Q. 3 (c) Simple Vapor absorption system:

A Simple Vapor absorption system consists of evaporator, absorber, generator, condenser, expansion valve, pump & reducing valve. In this system ammonia is used as refrigerant and solution is used is aqua ammonia.

Strong solution of aqua ammonia contains as much as ammonia as it can and weak solution contains less ammonia. The compressor of vapor compressor system is replaced by an absorber, generator, reducing valve and pump.

The heat flow in the system at generator, and work is supplied to pump. Ammonia vapors coming out of evaporator are drawn in absorber. The weak solution containing very little ammonia is spread in absorber. The weak solution absorbs ammonia and gets converted into strong solution. This strong solution from absorber is pumped into generator.

The addition of heat liberates ammonia vapor and solution gets converted into weak solution. The released vapor is passed to condenser and weak solution to absorber through a reducing valve. Thus, the function of a compressor is done by absorber, a generator, pump and reducing valve. The simple vapor compressor system is used where there is scarcity of electricity and it is very useful at partial and full load. **------- 2 Marks**



For figure 02 marks

Q. 3 (d) Following sensors are used in ECU: (Any 4 sensors…04 marks)

Crank angle sensor:

A permanent magnet inductive signal generator is mounted in close proximity to the flywheel, where it radiates a magnetic field. As the flywheel spins and the pins are rotated in the magnetic field, an alternating (AC) waveform is delivered to the ECM to indicate speed of rotation.

Air Flow Sensor (AFS):

The AFS is normally located between the air filter and the throttle body. As air flows through the sensor, it deflects a vane (flap) which wipes a potentiometer resistance track and so varies the resistance of the track and generates a variable voltage signal.

Manifold absolute pressure (MAP) sensor:

The MAP sensor measures the manifold vacuum or pressure, and uses a transducer to convert the signal to an electrical signal which is returned to the ECM. The unit may be designed as an independent sensor that is located in the engine compartment or integral with the ECM.

Coolant temperature sensor (CTS): The CTS is a two-wire thermistor that measures the coolant temperature. The CTS is immersed in the engine coolant, and contains a variable resistor that usually operates on the NTC principle.

Throttle Position Sensor (TPS): TPS is provided to inform the ECM of idle position, deceleration, rate of acceleration and wide-open throttle (WOT) conditions. The TPS is a potentiometer which varies the resistance and voltage of the signal returned to the ECM.

Oxygen sensor (OS): An oxygen sensor is a ceramic device 'placed in the exhaust manifold on the engine side of the catalytic converter. The oxygen sensor returns a signal to the ECM, which can almost instantaneously (within 50 ms) adjust the injection duration.

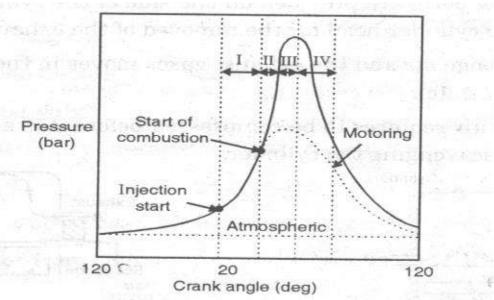
Q. 3 (e) Combustion in CI Engines: Explanation 03 marks …figure 01 mark There are four phases:

1) Ignition delay period : During this fuel has already admitted but has not yer ignited. This is counted from start of injection to the point where P-O curve separates from pure air compression curve.

2) Rapid or uncontrolled combustion : In this stage pressure rise because of during the delay period the fuel droplet have time to spread over a wide area and fresh air around them.

3) Controlled combustion : The temperature and pressure rise in the second state is quite high, hence droplet of fuel injected in stage burn faster with reduced ignition delay as soon as they find necessary oxygen and further pressure rise is controlled by injection rate.

4) After burning : This sage may not be present in all cases. Because of poor distribution of fuel particles, combustion continues during part of the remainder of the expansion stroke.



Stages of combustion in C.I. engine

Q. 4 (A) a) Explanation 03 marks …figure 01 mark

MPFI system :

The MPFI system is a port fuel-injection system in which, fuel metering is regulated by the engine speed and the amount of air which actually enters the engine. This is called air-mass metering or air-flow metering.

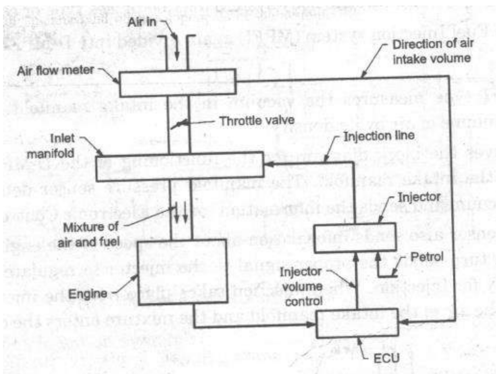
The block diagram of an MPFI system explaining its functioning is shown in Fig.

After the air enters into the intake manifold, the air-flow sensor measures the amount of air that enters into the intake.

The air-flow sensor sends the information of the air-flow meter to the ECU. Similarly, the speed sensor sends information about the speed of the engine to the ECU.

The ECU processes the information received and sends the proper signal to the injector, in order to regulate the amount of petrol supply for injection.

When injection takes place from the injector, the petrol mixes with the air in the intake manifold and the mixture enters the cylinder.



MPFI

Q.4.(A) b) 01 mark each

i) Indicated Power (ip) is defined as the power developed by combustion of fuel in the cylinder of engine. It is always more than brake power.

ii Brake Power:-

- The useful power which is available at the crank shaft is called as brake power.
- It is denoted by "B.P."
- It has unit kW

iii) **B.S.F.C:** It is the weight of fuel required to develop 1KW of the brake power for period of 1 hour. Unit of B.S.F.C is Kg/KWh.

It is defined as the amount of fuel consumed per unit of break power developed per hour.

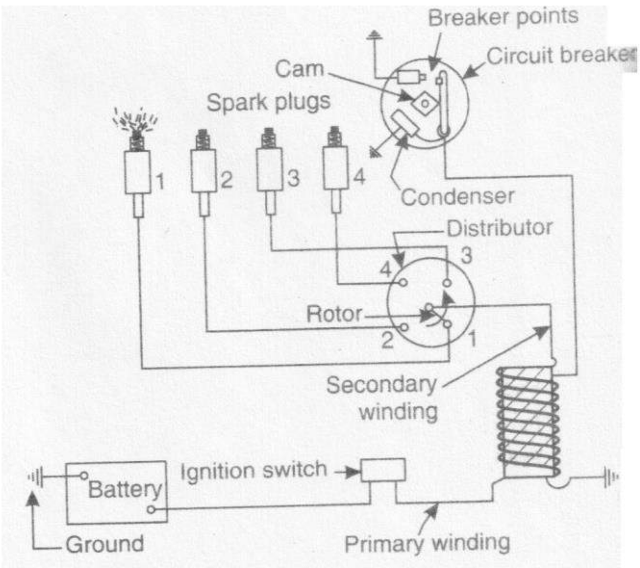
$$B.S.F.C = \frac{fuel\ consumption\ in\ Kg/hr}{Brake\ power\ in\ KW}$$

iv) **Relative efficiency** is defined as the ratio of indicated / brake thermal efficiency to the air standard efficiency.

Q4 A c) Battery Ignition system : I t consists of six or twelve volt battery, ignition switch,induction coil, circuit breaker condenser and distributor. All the circuit parts are shown in figure.

One terminal of battery is ground to engine frame and other is connected through the ignition switch to one primary terminal of induction coil. The other primary connection is connected to one end of contact point of circuit breaker and through closed points to ground.

The ignition switchis made on and engine is cranacked. When the contacts touch, the current flows the battery to the switch. Due to this primary winding of induction coil to circuit breaker points and circuit is completed. A condenser prevents sparking of this point. The rotating cam breaks open the contacts immediately and breaking of this primary circuit brings about change of magnetic field causing very high volt about 8000 to 12000 volts. Due to this high voltage the spark jumps across the gap in the spark plug and thereby it ignites mixture of air and fuel.



Q 4 A d) Method to measure Indicated power :

Indicated Power :

The power developed inside the engine cylinder is known as indicated power and denoted by I.P.

Measurement of indicated power :

Indicated power of engine at a particular speed can be calculated with the help of indicator. The indicator is fitted to the engine cylinder.

The strength of the spring to be used in the indicator must be carefully chosen.

The ratio of maximum pressure in the engine cylinder to the mean pressure during the cycle in an I.C. engine is much greater than that of any other heat engine.

The variation of pressure inside the engine cylinder is obtained an a diagram called as indicator diagram as shown in Fig.

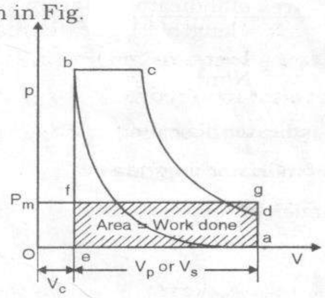


Fig. 2.1

The diagram obtained is a curved abcd the area under the curve is workdone as shown in P-V diagram work obtained = A (a – b – c – d).

Area (a b c d) into rectangle of length equal to stroke volume as shown in Fig. 2.1.

$$A(a-b-c-d) = A(a-e-f-g)$$

Consider height of rectangle as mean effective pressure (P_m)

∴ Average variation of pressure inside engine cylinder equal to P_m

$$\text{work/cycle} = A(a-b-c-d) = A(a-e-f-g) = P_m V_s$$

$$= P_m A \times L$$

$$= P_m \times \frac{\pi}{4} d^2 L$$

$$\text{Indicated power} = \text{workdone/cycle} \times N$$

$$= P_m A L N$$

Where N is speed of engine then N number of power stroke or explosion.

a) For two stroke engine

$$\text{I. P.} = P_m A L N$$

b) For four stroke engine

$$\text{I. P.} = P_m A L \times \frac{N}{2}$$

$$N = \frac{N}{2}$$

because one power stroke is completed in two revolution of crankshaft. Indicated mean effective pressure can be calculated as,

$$P_m = \frac{\text{Area of indicator diagram} \times \text{spring index}}{\text{length of indicator diagram}}$$

$$= \frac{a \times s}{l} \text{ N/m}^2$$

where a = Area of indicator diagram

l = length of indicator diagram

s = spring index in N/m^2 per meter.

Q. 4) B) a) Role of following lubricant additives (one mark each)

1. **Zinc ditinophosphate: -** Zinc ditinophosphate serves as an anti – oxidant and anticorrosive additive.
2. **Fatty acids: -** This type of additives prevents rusting of ferrous engine parts during and form acidic moisture accumulation during cold engine operation.
3. **Organic Acids: -** This type of additives improves the detergent action of lubricating oil.
4. **Ester: -** To lower the pour point of lubricating oil.
5. **Silicon polymers: -** This additive serves as Antifoam Agent.
6. **Butylene polymers: -** This type of additives added in lubricating oil to increase their viscosity index.
7. **Zinc ditinophosphate: -** Zinc ditinophosphate serves as an anti – oxidant and anticorrosive additive.
8. **Fatty acids: -** This type of additives prevents rusting of ferrous engine parts during and form acidic moisture accumulation during cold engine operation.
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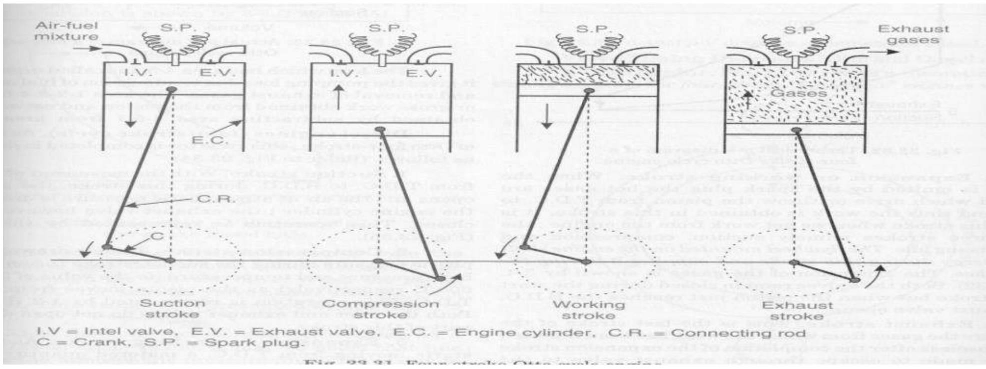
11. **Silicon polymers: -** This additive serves as Antifoam Agent.
12. **Butylene polymers: -** This type of additives added in lubricating oil to increase their viscosity index.

Q4 B b) (Two marks for figure and two for explanation)

Working of Four stroke petrol engine:



1. **Suction stroke**: Suction stroke starts when piston is at top dead center and about to move downwards. During suction stroke inlet valve is open and exhaust valve is closed. Due to low pressure created by the motion of the piston towards bottom dead center, the charge consisting of fresh air mixed with the fuel is drawn into cylinder. At the end of suction stroke the inlet valve closes.

2. **Compression stroke**: During compression stroke, the compression of charge takes place by return stroke of piston, i.e. when piston moves from BDC to TDC. During this stroke both, inlet and exhaust valve remain closed. Charge which is occupied by the whole cylinder volume is compressed up to the clearance volume. Just before completion of compression stroke, a spark is produced by the spark plug and fuel is ignited. Combustion takes place when the piston is almost at TDC.
3. **Expansion or power stroke**: Piston gets downward thrust by explosion of charge. Due to high pressure of burnt gases, piston moves downwards to the BDC. During expansion stroke both inlet and exhaust valves remains closed. Thus power is obtained by expansion of products of combustion. Therefore it is also called as 'power stroke'. Both pressure as well as temperature decreases during expansion stroke.

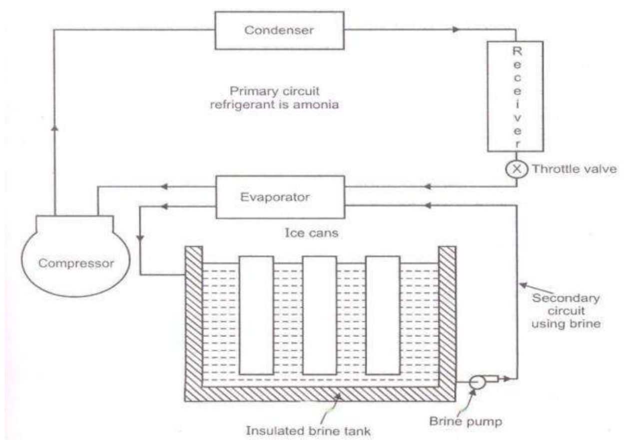
4. **Exhaust stroke**: At the end of expansion stroke the exhaust valve opens, the inlet valve remains closed and the piston moves from BDC to TDC. During exhaust stroke the burnt gases inside the cylinder are expelled out. The exhaust valve closes at the end of the exhaust stroke but still some residual gases remains in cylinder.

Q. 5 (a) Working of Ice plant: (Explanation 05 marks ….fig 03 marks)

The main cycle used for ice plant is vapor compression cycle with ammonia as the refrigerant in primary circuit and brine solution in secondary circuit. Brine solution takes heat from water in secondary circuit and delivers the heat to ammonia in primary circuit. Thus, the indirect method of cooling is used in ice plant. In secondary circuit brine is cooled in evaporator and then it is circulated around the can which contains water.

The heat is extracted from the water in the can and is given to the brine. The brine is contentiously circulated around the can with the help of brine pump till entire water in the can is converted into ice at -6^0 C. Ammonia vapor coming out of evaporator is compressed to high pressure and then these vapors are condensed in the condenser.

High pressure liquid ammonia is collected in the receiver and it is passed through the expansion valve to reduce its pressure and temperature as per requirement. The throttle liquid ammonia at low temperature & low pressure enters in evaporator, which are the coils dipped in brine tank. The liquid ammonia absorbs heat from brine and gets converted into vapors, which are drawn by suction line of compressor.



Q5 b)

Q5. (b)

$$\text{Indicated Power} = \frac{n}{n-1} P_1 V_1 \left[\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1 \right]$$

$$= \frac{n}{n-1} m R T_1 \left[\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1 \right]$$

$$= \frac{1.25}{1.25-1} \times \frac{10}{60} \times 0.287 \times 300 \left[(6)^{\frac{0.25}{1.25}} - 1 \right]$$

$$= \underline{30.852 \text{ kW}} \quad (2 \text{ marks})$$

Assuming mechanical efficiency as 80%.

$$\text{Power required to drive compressor} = \frac{30.852}{0.8}$$

$$= \underline{38.565 \text{ kW}} \quad (2 \text{ marks})$$

$$\text{Isothermal power} = P_1 V_1 \log_e P_2/P_1$$

$$= m R T_1 \log_e P_2/P_1$$

$$= \frac{10}{60} \times 0.287 \times 300 \times \log_e 6/1$$

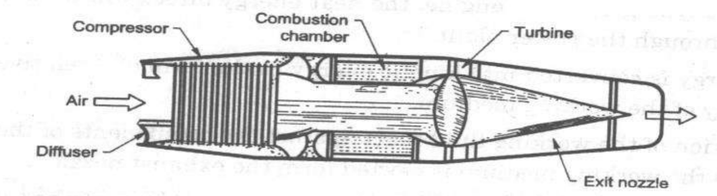
$$= \underline{25.71 \text{ kW}} \quad (2 \text{ marks})$$

$$\text{Isothermal efficiency} = \frac{\text{Isothermal Power}}{\text{Indicated Power}}$$

$$= \frac{25.71}{30.852} = \underline{83.35\%}$$

Q5 c) Turbojet Engine (Explanation 05 marks ….fig 03 marks)

Turbo-Jet Engine :



Turbo-jet engine

The turbojet engine consists of an open cycle gas turbine engine (compressor, combustion chamber and turbine) with an entrance air diffuser added in front of the compressor and an exit nozzle added rear end or aft of the turbine.

In this unit no propeller is provided. The diffuser of a turbojet engine must provide the greatest possible pressure rise by slowing the incoming air and converting its kinetic energy into pressure.

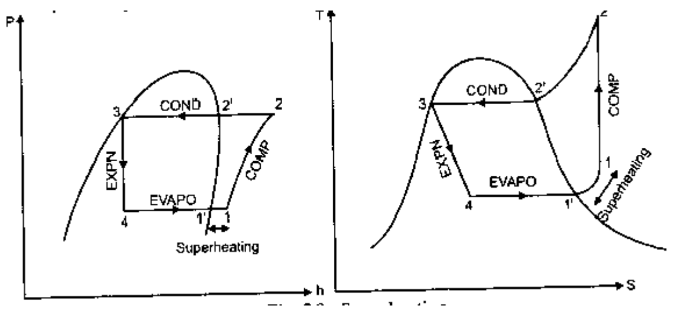
The shape, area and location of the actual air inlet in an aeroplane is highly important. Variable area entrance diffusers are being developed for new aircraft in order to maintain high diffuser efficiency for both high and low speed operation. The atmospheric air enters the compressor through the front opening.

The compressor compresses the air to the required pressure and discharges it into combustion chamber. The fuel is injected into the combustion chamber at constant pressure.

The gases leaving the combustion chamber expand in turbine, which produces sufficient power to run the compressor and exhaust to atmospheric through nozzle, which produces propulsive thrust to drive the unit.

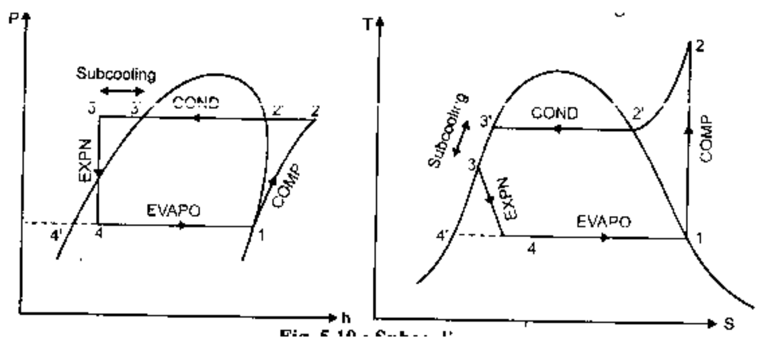
The major advantages of the use of axial flow compressor is capable of multistaging and small frontal area, out weight its sensitivity and fragility. Therefore it is the current choice for use in turbojet engine of high thrust output.

Q6 a) Superheating (sketch & explanation – 2 marks)



Due to superheating suction temperature of compressor increases , increasing compressor power but it also increases the refrigerating effect therefore COP of system remains more or less constant. The superheating is not done to increase the refrigerating effect or COP but it is done to increase the life of compressor.

Sub-cooling **(sketch & explanation – 2 marks)**

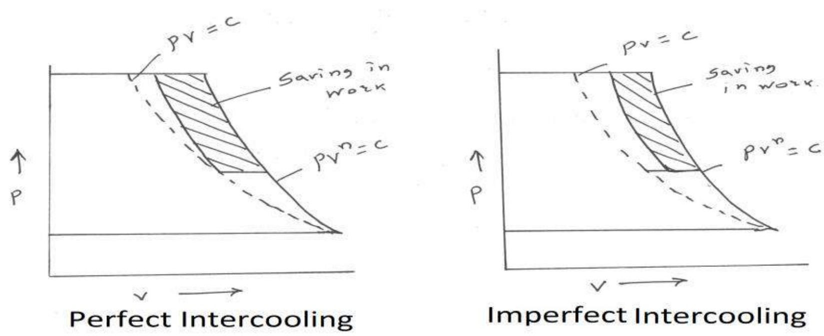


The process of cooling refrigerant below condensing temperature for a given pressure is known as sub-cooling. Due to sub-cooling the refrigerating effect increases or for same refrigerating effect the circulation rate refrigerant decreases and therefore COP of system increases. Thus sub-cooling is desirable & is done to increase refrigerating effect & COP of system.

Q6 b) **(01 mark each for figure & explanation)**

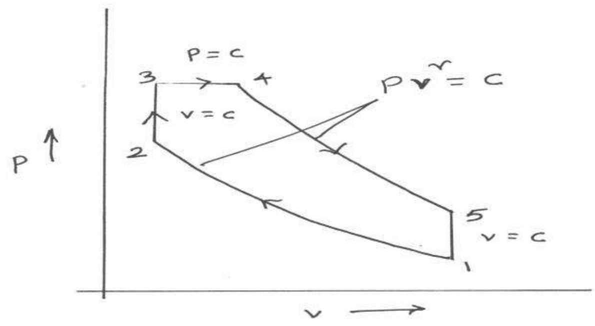
Perfect cooling: In this process the temperature of air after passing out of intercooler is same as that of temperature of air before compression in LP cylinder. The respective figure is shown.

Imperfect cooling: In this process the temperature of air after passing out of intercooler is between the temperature of air before & after compression in LP cylinder. The respective figure is shown.



Q6 c) Dual cycle:

(02 marks for figure & 02 marks for processes)



Process 1-2 : Isentropic compression

Process 2-3: Partial Heat addition at constant volume

Process 3-4 : Partial Heat addition at constant pressure

Process 4-5 : Isentropic expansion

Process 5-1: Heat rejection at constant volume

Q6 d) Air conditioning systems are classified as

1) Classification as to major function-

i) Comfort air-conditioning - air conditioning in hotels, homes, offices etc.

ii) Commercial air-conditioning- air conditioning for malls, super market etc

ii) Industrial air-conditioning – air conditioning for processing, laboratories etc

2) Classification as to season of the year-

i) Summer air-conditioning - These system control all the four atmospheric conditions for summer comfort.

ii) Winter air-conditioning – This system is designed for comfort in winter.

iii) Year round air-conditioning – These system consists of heating and cooling equipments with automatic control to produce comfortable condition throughout the year

3) Classification as to Equipment Arrangement-

i) Unitary system ii) Central system

Q . 6 (e) Any four points…………………………..…..(1x4=4)

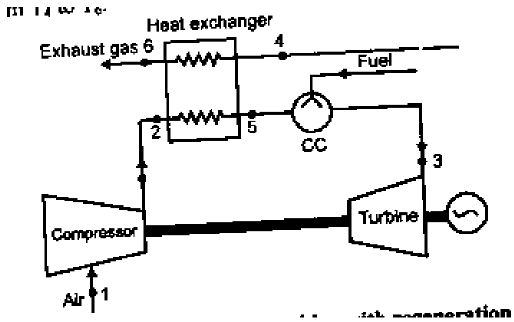
Sr.no	Factors	Open cycle gas turbine	Closed cycle gas turbine
1.	**Pressure**	Lesser pressure	Higher pressure
2.	**Size of the plant for given**	Larger size	Reduced size
3.	**Output**	Lesser output	Greater output
4.	**Corrosion of turbine**	Corrosion takes place due to	No corrosion since there is
5.	**Working medium**	Loss of working medium	No loss of working medium.

6.	**Filtration of incoming air**	It may cause severe problem.	No filtration of air is required.
7.	**Part load efficiency**	Less part load efficiency	More part load efficiency
8.	**Thermal efficiency**	Less thermal efficiency	More thermal efficiency
9.	**Requirement of cooling**	No Requirement of cooling water	Larger amount of cooling
10.	**Weight of system for**	Less	More
11.	**Response to the changing**	Good response	Poor response
12.	**Fluid friction**	More Fluid friction	Less Fluid friction

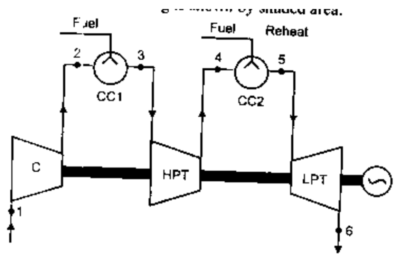
Q6 f) Methods to improve thermal efficiency of gas turbine

(List of methods -2 marks, explanation of any one – 2 marks)

1) Regeneration – This is done by preheating the compressed air before entering to the combustion chamber with the turbine exhaust in a heat exchanger, thus saving fuel consumption.



(a) Reheating : The whole expansion in the turbine is achieved in two or more stages &reheating is done after each stage.



(a) Intercooling